

Abstract

Limited understanding exists regarding the association between extreme weather events and risk of *Campylobacteriosis*, particularly for communities in coastal regions. We linked laboratory culture-confirmed cases of *Campylobacteriosis* for Maryland (2002-2012) with extreme temperature and precipitation events calculated using a 30-year baseline (1960-1989). We employed multivariate negative binomial regression utilizing generalized estimation equations to investigate the associations between *Campylobacteriosis* and extreme weather events. A one-unit increase in extreme precipitation event was associated with a 5% increase in risk of *Campylobacteriosis* in the Eastern Shore region (IRR 1.05, 95% CI: 1.02, 1.09). The increase in risk associated with extreme precipitation was particularly higher during the El Niño period (IRR 1.10, 95% CI: 1.06, 1.13). Our data suggests that *Campylobacteriosis* is associated with extreme precipitation events in Maryland, with higher risk in the coastal region and during El Niño periods. Extreme precipitation related flooding in coastal areas could bring water contaminated with bacterial pathogens (originating from point sources such as municipal wastewater treatment plants and animal feeding operations) into close proximity with individuals, where frequency of contact (via swimming or recreation) may be higher. Increased risk associated with the El Niño period could be related to the more intense precipitation events during this time period.

Introduction

- 2nd most common cause of food and waterborne disease (behind salmonella) with 1.3 million people affected annually in the U.S.
- Estimated negative impact to the U.S. economy is \$6.9 billion (e.g. medical care, quality of life, productivity loss, etc...)
- Incidence rates continue to rise despite interventions focused upon food safety operations
- Climatic factors (i.e., extreme temperature and precipitation events) may impact a pathogen’s ability to develop and its routes of transmission
- United Nations International Panel on Climate Change projects extreme weather events to increase in intensity, frequency, and duration
- Limited understanding of the impact that extreme weather events have upon the risk of campylobacteriosis

Methods

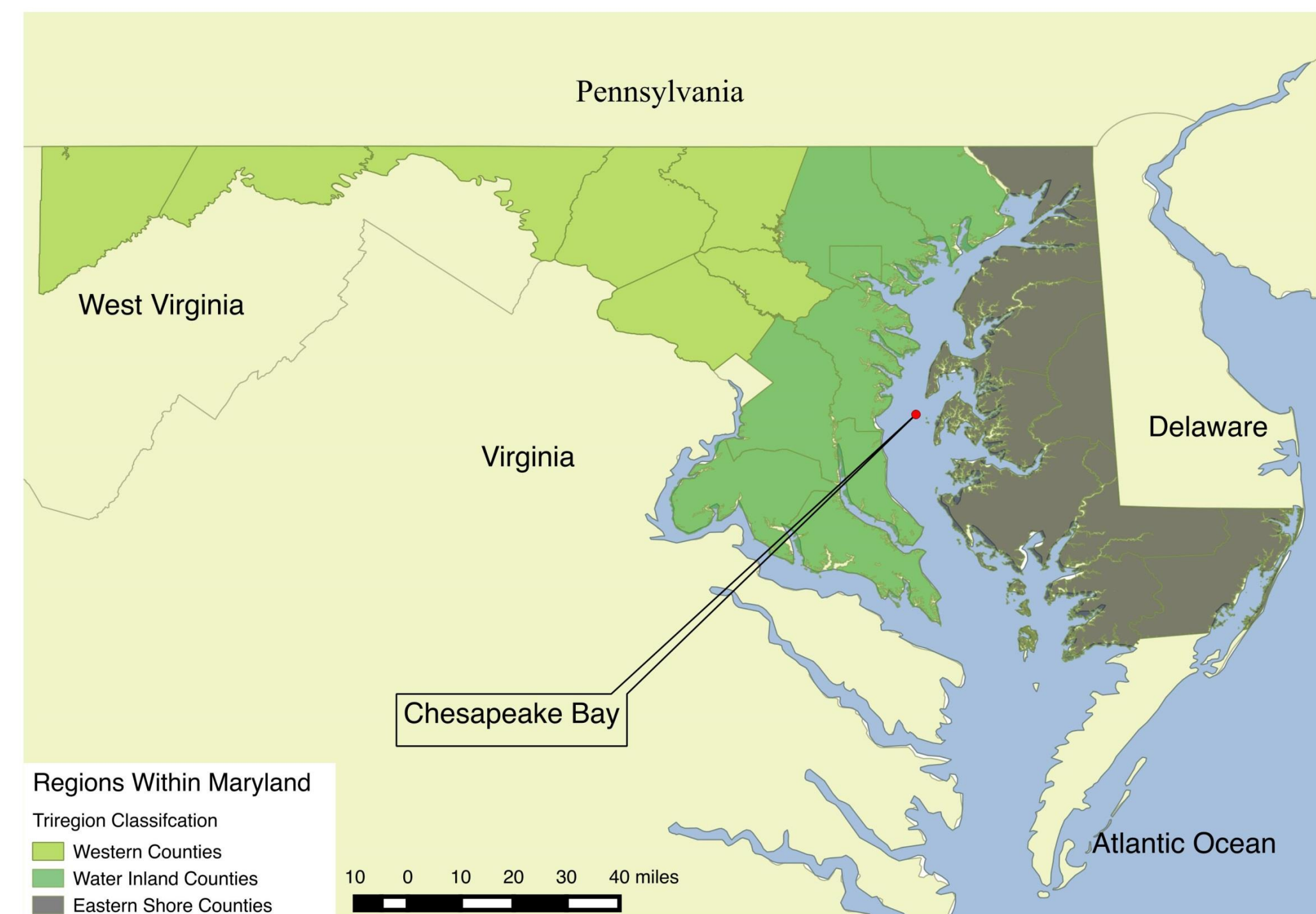


Table 1. Campylobacteriosis Case Demographic and Regional Characteristics for Maryland, 2002-2012

Characteristic	Cases - No. (%)			
	Maryland Counties Segmented by Region			Total
	Water Inland (n = 2385)	Western (n = 1893)	Eastern Shore (n = 526)	(n = 4804)
Gender				
Male	1261 (53)	1025 (54)	294 (56)	2580 (54)
Female	1121 (47)	861 (46)	231 (44)	2213 (46)
Unknown	3 (0.1)	7 (0.3)	1 (0.2)	11 (0.2)
Age at hospital admission [median (interquartile range)] (years)	39 (22-54)	36 (18-53)	38 (17-55)	38 (20-53)
Age Group				
<5	247 (10)	205 (11)	61 (12)	513 (11)
5-17	233 (10)	260 (14)	76 (15)	569 (12)
18-64	1634 (69)	1231 (65)	319 (61)	3184 (66)
≥65	266 (11)	188 (10)	68 (13)	522 (11)
Unknown	5 (0.2)	9 (0.5)	2 (0.4)	16 (0.3)
Race/Ethnicity				
Non-Hispanic White	1365 (57)	707 (37)	354 (67)	2426 (51)
Non-Hispanic Black	331 (14)	36 (2)	40 (8)	407 (9)
Hispanic	121 (5)	76 (4)	26 (5)	223 (5)
Other	81 (3)	57 (3)	5 (1)	143 (3)
Unknown	487 (20)	1017 (54)	101 (19)	1605 (33)
Season ^a				
Winter	390 (16)	318 (17)	64 (12)	772 (16)
Spring	463 (19)	382 (20)	106 (20)	951 (20)
Summer	933 (39)	800 (42)	235 (45)	1968 (41)
Autumn	599 (25)	393 (21)	121 (23)	1113 (23)
ENSO Period				
ENSO Neutral	1277 (54)	1024 (54)	284 (54)	2585 (54)
El Niño	559 (23)	472 (25)	123 (24)	1154 (24)
La Niña	549 (23)	397 (21)	119 (23)	1065 (22)
Poverty Status ^b				
Quartile 1	497 (21)	1732 (92)	No Counties ^c	2229 (46)
Quartile 2	1116 (47)	No Counties ^c	112 (21)	1228 (26)
Quartile 3	282 (12)	71 (4)	215 (41)	568 (12)
Quartile 4	490 (21)	90 (5)	199 (38)	779 (16)

^aPercentages may not add to 100% due to rounding.
^bThese counties did not have any case data that was classified in the specified quartile. ^cQuartile 1 values were 4.4 to 6.64%, Quartile 2 values ranged from 6.65 to 8.59%, Quartile 3 ranged from 8.6 to 12.92%, and Quartile 4 ranged from 12.93 to 23.4%. ^dSeasons were Winter (December-February), Spring (March-May), Summer (June-August), and Autumn (September-November).

Study

- Maryland counties split into 3 regions (Eastern Shore, Water Inland, & Western)

Data

- Maryland Foodborne surveillance network (2002-2012)

Approach

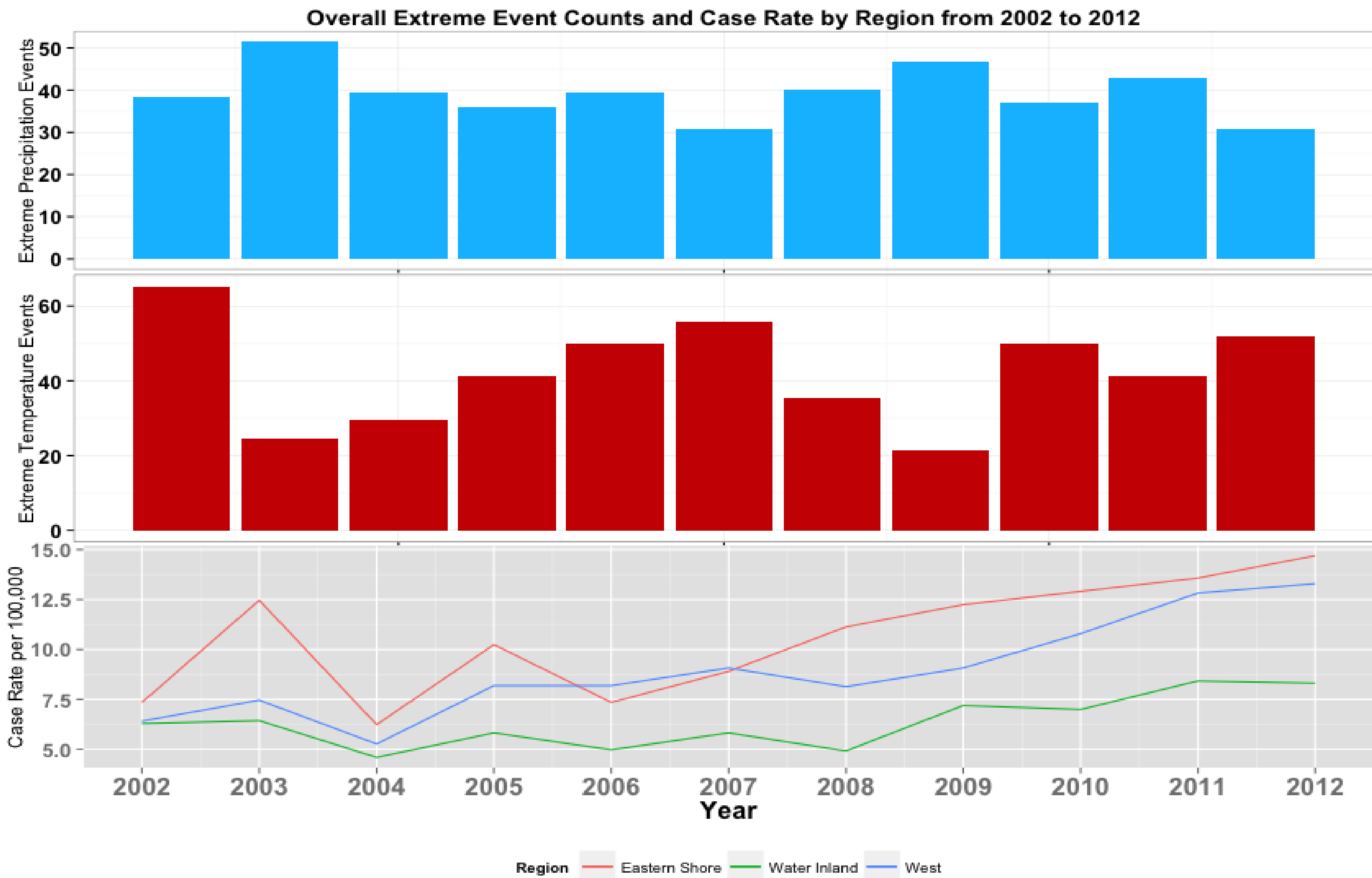
- Case data linked with location and calendar day specific extreme temperature and precipitation events calculated using a 30-year baseline (1960-1989)
- Extreme temperature and precipitation events determined based upon 90th percentile threshold

Statistical Analysis

- Negative binomial regression utilizing generalized estimation equations was used to investigate the associations between *campylobacteriosis* and extreme weather events

Results

Frequency of Extreme Events & Campylobacterosis Incidence Rate



Stratified Analysis: Incident Rate Ratios (95% CI) for Extreme Precipitation (EPT₉₀) and Extreme Temperature (ETT₉₀) Events

Characteristic	Precipitation (EPT ₉₀)	Temperature (ETT ₉₀)
Season		
Winter	0.99 (0.94, 1.04)	0.96 (0.94, 0.98)
Spring	1.00 (0.96, 1.03)	0.95 (0.92, 0.99)
Summer	1.00 (0.98, 1.02)	1.00 (0.99, 1.02)
Autumn	1.01 (0.97, 1.04)	0.97 (0.94, 1.01)
Region		
Eastern Shore	1.05 (1.02, 1.09)	1.00 (0.97, 1.03)
Water Inland	1.02 (1.00, 1.04)	1.00 (0.98, 1.02)
Western Counties	1.01 (0.98, 1.05)	1.00 (0.97, 1.02)
ENSO Period		
ENSO Neutral	1.02 (0.99, 1.04)	1.00 (0.98, 1.03)
El Niño	1.10 (1.06, 1.13)	1.01 (0.99, 1.02)
La Niña	0.96 (0.93, 1.00)	0.99 (0.97, 1.01)

Summary & Implications

Summary

- Eastern shore and Water Inland counties found to have increased risk of 5% and 2% with extreme precipitation events, respectively
- Association between extreme precipitation and *Campylobacteriosis* was particularly high during El Niño periods
- No association found with extreme temperature events

Direction of Future Research

- Risk analysis can be integrated into future disease burden projections
- Communities developing adaptation strategies to climate change need to be informed of potential risks associated with extreme weather events and *Campylobacteriosis*

Acknowledgements

Research Collaborators

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